ROCKS UNFOLD THE PAST

ROCKS UNFOLD THE PAST

VISHNU MITTRE

NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

May 1973

Vaisakha 1895

P. U. 5 T

Rs. 2.00

PUBLISHED AT THE PUBLICATION UNIT BY M. C VERMA, SECRETARY, NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING, SRI AUROBINDO MARG, NEW DELHI 16 AND PRINTED AT VENUS PRINTING WORKS, 52/7 B B GANGULY STREET, CALCUTTA-12

FOREWORD

Every one of us comes across one or the other type of rocks in our environment at a very early stage A piece of rock arouses curiosity to know 'how it was formed', 'what it is made of' and so on Somehow or the other our school courses do not cover much of the Earth Science area which may help children to understand such fascinating problems about rocks This publication brings out various facts on different aspects dealing with the origin and development of the earth as revealed by rocks. Dr Vishnu Mittre, who has wide experience in the field, has taken special care to make the Supplementary Reader, 'Rocks Unfold the Past' interesting with the help of a number of illustrations and photographs.

It is hoped that this Reader will stimulate amongst the young school students an interest in a deeper study of rocks. The Council is grateful to the author for this.

The Council is also grateful to the staff of the Publication Unit and the Department of Science Education for their contributions to this publication.

S V C Aiya
Director
National Council of Educational Research and Training

New Delhi
21 August 1972

PREFACE

The nature around us is very captivating. The more we know of it, the more interesting it becomes More puzzling are the natural phenomena that happen before us. Has nature been the same since time immemorial, and have the same natural phenomena occured in the past as we witness them today ? What kind of plants and animals existed in the past and what were the climates then ? Have man and his cultures, the rivers, the mountains, the forests and the oceans existed in much the same way in the past as they do today ? There could be scores of such interesting questions the answers to which are preserved in the rocks. It seems unbelievable, but it is very much true.

To an unintiated mind rocks are hard and stony and meaningless structures. It is indeed worth knowing that the rocks are of various kinds and that some of them were formed many hundreds of millions of years ago, others later and some of them are forming even today. It is fascinating to know the way they were formed and the way the information of the past events has entered into them and has been preserved Some of the rocks have disappeared due to crumbling and disintegration, and the information they had contained has been lost for ever. From the study of rocks valuable information has been obtained of the origin and evolution of the earth, of past climates, of our forests and of animals including our species, of our soils and lastly of the human cultures that lived in the past. Thus, a piece of

rock is a store-house for the information of the past. It is on this account that rocks have been likened to the pages of Nature's Story Book The rocks have been dated precisely in terms of years thus giving us a time-scale against which to date the events of the past

Rocks of various kinds from the oldest to the most recent occur in various parts of India, and from their study interesting information has been obtained of the various aspects of the past history of India In this Supplementary Reader 'Rocks Unfold the Past' an attempt has been made to acquaint the young students with the various kinds of rocks, how they are formed and dated and how the various events of the past can be read out from them The information of the past as unfolded by Indian roeks is presented in a simple and lucid style, and the contents, examples and illustrations are all drawn from the Indian environment. The teehnical terms have been avoided as far as possible and those which could not be avoided are explained in the Glossary

The chief object of this Reader has been to broaden the interest of young students in the disciplines of science to which rocks belong, i.e. Geology and the related sciences and to expose them to scientific facts and concepts It is hoped that this supplementary reading material will stimulate a deeper and wider interest in science among the school students in our country.

'My thanks are due to the authorities of Birbal Sahni Institute of Palaeobotany Lucknow, for kindly permitting me to undertake

the writing of this Reader. This being a national task, I have drawn freely from literature and illustrations published in Indian books and journals. My special thanks are due to the Director-General, Geological Survey of India ; to the Secretary, National Institute of Sciences (now Indian National Science Academy) New Delhi, and to the Editor, 'Everyday Science' for the permission to reproduce illustrations from their publications.

The illustrations have been reproduced skilfully by the late Shri. R. N. Takru, Artist, Birbal Sahni Institute of Palaeobotany, Lucknow, to whom my thanks are also due.

I am also indebted to the late Professor D. N. Wadia, FRS, formerly National Professor of Geology, and to Dr M. S Randhawa, D Sc F.N.A , presently Vice-Chancellor, Punjab Agricultural University, Ludhiana, for kindly going through the manuscript and for suggesting improvements.

Lastly I wish to express my sincere appreciation to Shri K J. Khurana of the Department of Science Education, National Council of Educational Research and Training, New Delhi, for the help received at various stages in the preparation of this Reader.

Lucknow
7 August 1972

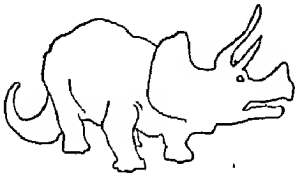
VISHNU MITTRE

CONTENTS

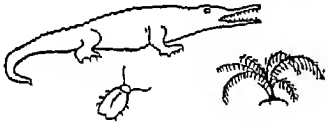
	FOREWORD	v
	PREFACE	vii
1.	Nature's Story Book	1
2.	Rocks and their Kinds	5
3.	Rocks that Depict the Past	14
4.	Dating the Events	24
5.	The Origin of the Earth	26
6.	The Birth and the Early Beginnings of India	27
7.	The Dark Age	29
8.	The Gondwana Land	31
9.	The Shaping of Modern India	37
10.	Rocks and the History of Man	43
11.	The Procession of Life	48
	Glossary of Technical Terms	57

AGE OF MAN

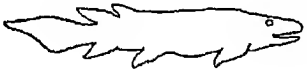
AGE OF MAMMALS



AGE OF REPTILES



COAL AGE



AGE OF FISHES

AGE OF TRILOBITES

AGE OF SIMPLE PLANTS AND ANIMALS

Geological time-table

1. Nature's Story Book

LET US OPEN nature's story book anywhere, and we will find that it is marked with strange events. In the year 1819, the people of the Rann of Kutch were shocked to see 5000 square kilometres of land sink below the sea to a depth of about 4 metres. The Port of Sindre, an important historical site, stood on the edge of the sea ; then, all of a sudden it was submerged. A single turret was all that could be seen Simultaneously, a piece of land about 1,500 square kilometres was raised several feet above the ground. This new piece of land was called the Allah Bund by the people of the locality.

The course of nature is never smooth. Its four seasons often experience unusual weather ; such as rain, a chilling cold wave, dust-storms and cyclones. Rivers are in spate and landslides disrupt roadways. Earthquakes cause immense loss to life and property.

India, like other lands, is often a victim of nature's deeds For instance, a great natural calamity took place on 12 June, 1897 It began with a roaring sound of an extraordinary nature, and, in less than a minute, the town of Shillong and the adjoining regions of Assam became a waste land. This destruction was spread over an area of almost 41,50,000 square kilometres. The plains

were flooded and torn and the hillocks broken down into masses of mud which slipped down the slopes. Stones were uprooted and tossed in the air, like peas on a drum. Wide fissures were formed in the rocks and in the earth from which sprouted volumes of water. Sand was blown up to a height of almost one metre in the air. It resulted in complete disruption of land communication. This volcanic convulsion was an earthquake.

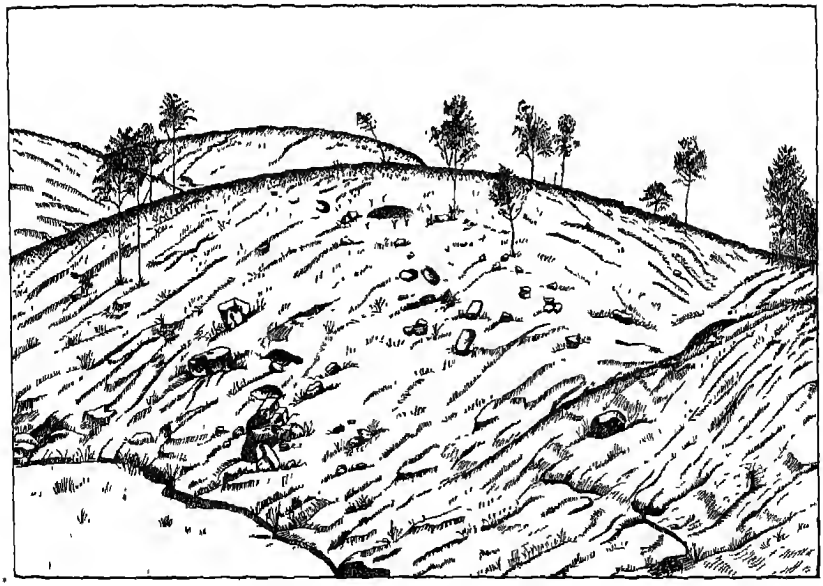


Fig. 1
Stones uprooted and tossed over

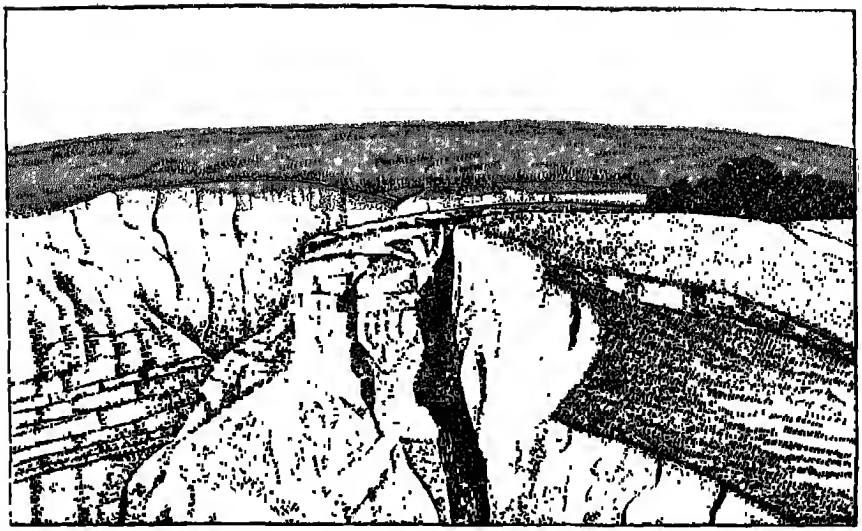
There have been several earthquakes in our country and in Pakistan. The latest was the one which shook Mekran Coast in November, 1945. A violent tidal wave rose about 12 metres high and there was an eruption of mud. A tidal wave, 2 metres high, swept away the shores of Bombay. An interesting feature noticed during this earthquake was the appearance of a small island, a few miles off the coast.

Such events, as described above, are no less amazing than Aesop's Fables. (Events of today, when recorded, become the events of the past, and eventually make history). You get to know about them either through human memory or writings. Neither human memory nor written records go very far back into the times gone by. The art of writing is a comparatively recent discovery. Your sense of wonder will be aroused by happenings over eons of time. Man began to write only a few thousand years ago. But the question that you will ask is—What events took place during this long period of time?

Long ago when neither Man, nor his art of writing were there, all events of the kind which we observe today, were written by Nature in its own language and in its Story Book. During the course of time, which ran into millions of years, Nature's Story Book has been spoiled in many ways. Some of its pages have been burnt, others torn and reduced to scraps and some have been blown away. The writing on them has been blurred.

From the blurred and fragmentary pages of Nature's Story Book, it may never be possible to read a complete and continuous history of the past. Nevertheless, they can provide glimpses of stirring events, changes in the physical world and the unfolding of the panorama of life.

Rocks are the pages of Nature's Story Book. They have preserved, partly or wholly, the records of past events. To read and understand Nature's Story Book you should always be adventurous, and possess the ability to observe what is happening before your eyes, since it is through the happenings of today that we recognize the events of the past. The present is the key to the past.



Fissures in sandstone formed by earthquake

Ancient caves made in massive sandstone

2. Rocks and Their Kinds

Most of us look upon a rock as a hard and stony substance. You may want to know how such a soft thing as mud is also a rock. Scientists tell us that a rock can be soft as well as hard. Similarly, sand and pebbles are also rocks.

Mud as you all know is formed in water. It may be in a lake or in a sea. Rivers carry huge loads of mud, sand and pebbles into the sea. Pebbles being heavy settle at the bottom first and then they make a layer. Sand forms a layer over the layer of pebbles and mud over that of sand. Thus rocks made under water are made up of layers. As the layers are piled up, a lake or a sea may be filled up and then disappear. When dry these softer rocks become hard. All such rocks which are made under water are called sedimentary rocks.

On drying up, mud becomes shale and sand becomes sandstone. A mixture of sand, mud and pebbles makes conglomerate. You can see some of them in the illustrations. (See Figs. 2 and 3)

Some shale and sandstone are grey, some are pink or red and some are yellow in colour. Shale may also be black in colour. The famous Red Fort in Delhi is made of red sandstone. Several other modern and

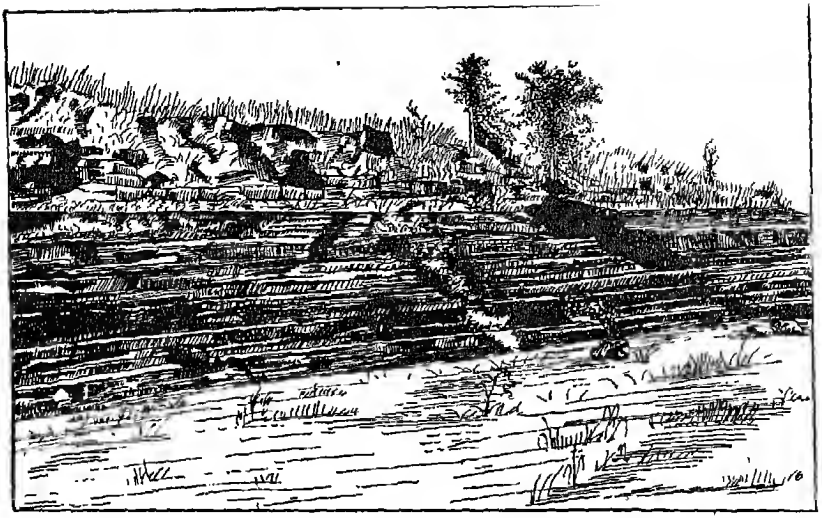


Fig 2
Soft and fragile shale with the horizontal layers of sediments

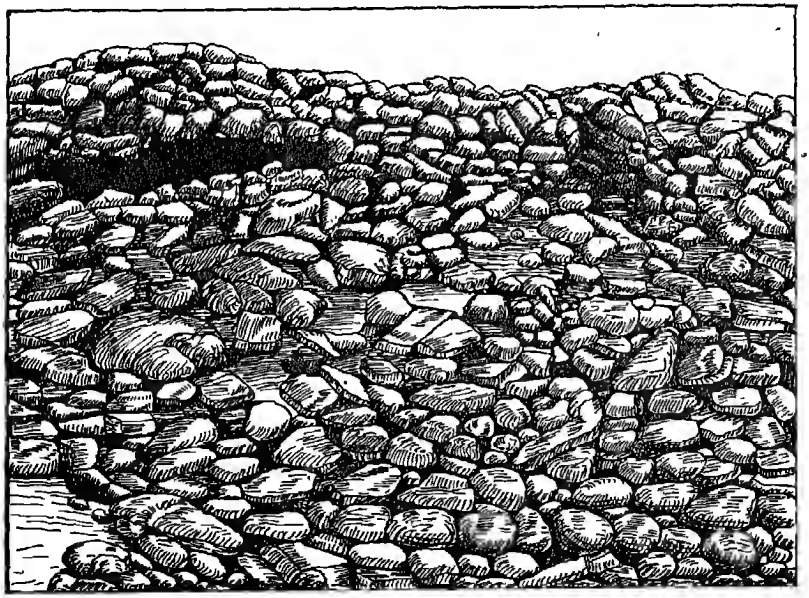


Fig. 3
Conglomerate made up of rounded and broken pebbles of varying sizes

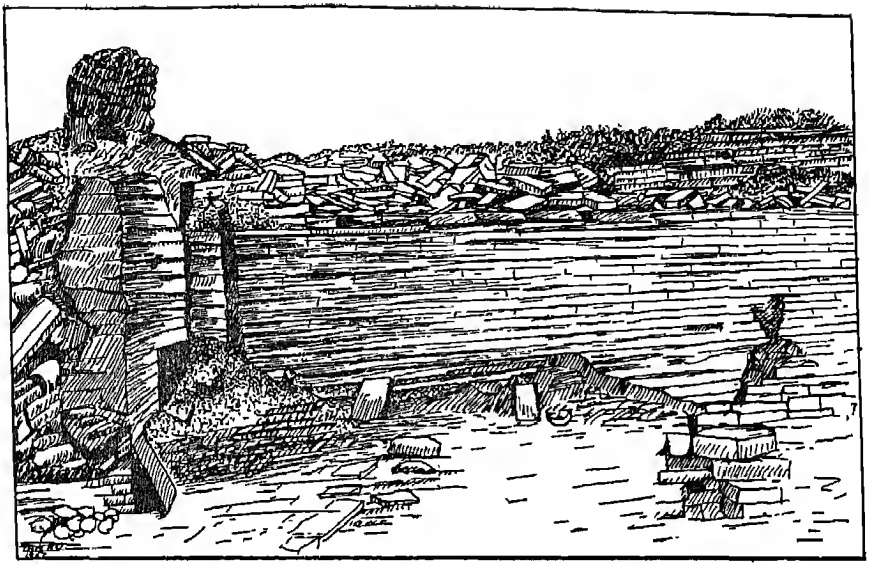


Fig. 4

Hard and compact limestone made up of thick horizontal layers each about one to two feet thick

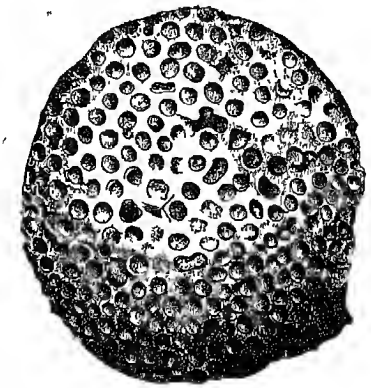


Fig. 5

A coral

ancient buildings in Delhi, Agra and Rajasthan are built of red and white sandstone.

It is not very difficult to tell one kind of rock from the other. You can easily feel the grains of sand in a sandstone. Moisten a piece of shale and it smells like mud. A limestone bubbles when a drop of hydrochloric acid is put on it.

Plants and animals which live in lakes and seas also help in the making of rocks. When they die, the harder parts of their bodies combine to make rocks. Corals and shells are made up of lime When they die, their dead bodies make limestone, Figs. 4 and 5.

You are quite familiar with the coal that you burn in your kitchen. It was made under water from plants that lived on earth several million years ago. But remember, not all coal is black, as is the coal in your kitchen. Coal can also be brown. It is called lignite. Thick deposits of brown coal are found in Madras, Rajasthan and Kashmir.

In the swamps of Nilgiris and Kashmir a kind of rock called peat is being formed. It is made of the dead remains of plants such as the stems, the roots and the fruits which you may easily see in it. Figs. 6 and 7 show coal and peat. Like coal, peat is also used as fuel.

Change is the law of Nature. So rocks also change. The change may be brought about by the pressure of the layers on top, or by the heat from within the earth. A

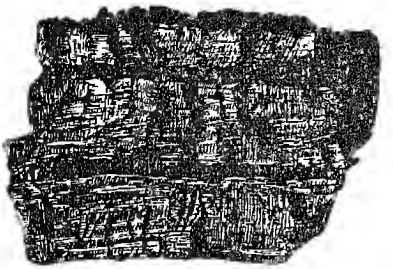


Fig. 6
A sample of coal with bands from the Jharia coalfield

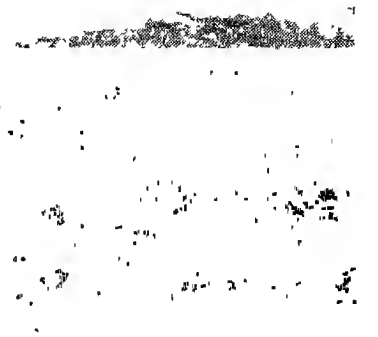


Fig 7
Peat

peat may change into brown coal and then into black coal. Shale may change into slate. Like shale, slate also smells like clay when wet. A sandstone may change into quartzite. It is much harder than sandstone. Limestone may become marble. The famous Taj Mahal at Agra is made of white marble. Conglomerate changes into schist.

Fig. 8
The compact black vertical rock on the right is quartzite. The rock on the left is schist. A line of pebbles is seen at the contact between the two

Fig. 8 shows some of these changed rocks. When rocks change, they are called metamorphic (changed) rocks.

There are certain other kinds of rocks. They are made in a different way. Perhaps, you know what a volcano is. When it erupts, hot liquid lava comes out of it. Lava is rock in the molten state. Rocks at great depths from the surface of the earth are not solid, but liquid. Sometimes steam or other gases may push out the hot liquid rocks from below the surface. The weight of the rocks above may also squeeze it out from within the earth. When so pushed out, the hot liquid rock spreads in the form of a flood It burns everything. It cools down slowly to form a rock called basalt. There may be volcanic ash also as you can see in Figs. 9-11.

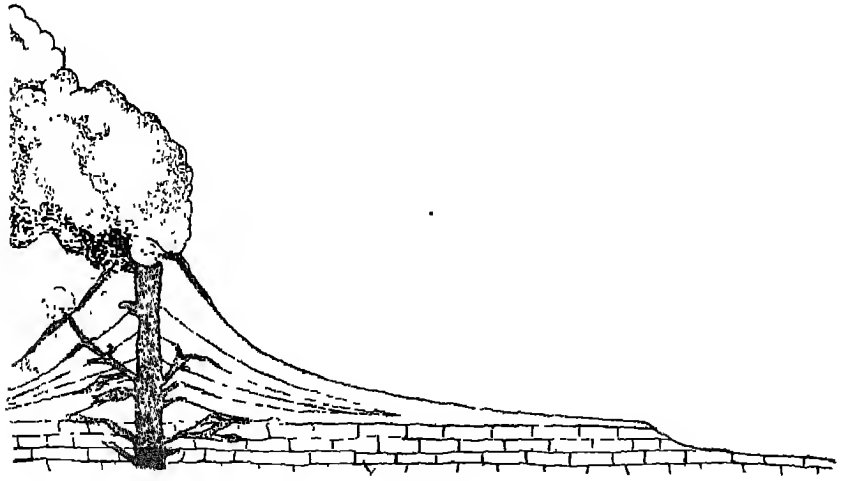


Fig. 9
A Volcano

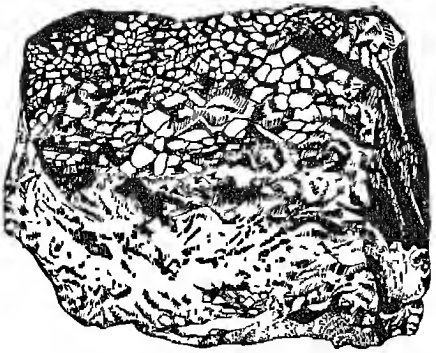


Fig. 10
A specimen of metamorphosed volcanic rock

Fig. 11
Volcanic ash with large boulders

Fig 12
Granite

Fig. 13

A specimen of Gneiss—a streaky coarse-grained metamorphosed rock full of intrusions

When this hot liquid cools down slowly below the earth, it makes crystalline rocks like granite. They are either white, red, grey or dark. Several ancient temples in South India are made from granite.

Rocks like granite and basalt made from hot molten matter are called Igneous rocks. The word igneous means fire.

Igneous rocks may also change. Granite changes into gneiss which has small streaks or bands. Both granite and gneiss are shown in Figs. 12-13.

3. Rocks that Depict the Past

IN ORDER TO read and understand Nature's Story Book one has to learn the language of Nature. A sand grain or a pebble is not simply a particle of dead matter. It is, in fact, a word or a phrase of the language in which Nature has written the history of the earth. Rocks made up of these particles are the pages of the book Several kinds of rocks, lying one upon another, make up the chapters of this "Great Book."

In order to know the past you must realise how important it is to recognize and have a proper knowledge of rocks. Your own curiosity will lead you to ask the question—how were they made and what do they contain ?

A sedimentary rock indicates former presence of a river, lake or sea A limestone or a rock salt tells you of a sea. Sometimes, on breaking open a piece of rock one finds the marks of animals, or of a leaf, or a fruit. These are the impressions of dead animals or plants which once lived in water, or accidentally fell into it, or were carried into it. These are called fossils. A piece of rock in Fig. 14 indicates the impressions of small ainmals. These fossils tell us, further, if it was a sea or a fresh water lake in which the rock was made, They also tell us

of the past climates. A piece of coal, for instance, would tell us the story of the swamp-forests in the ages past.

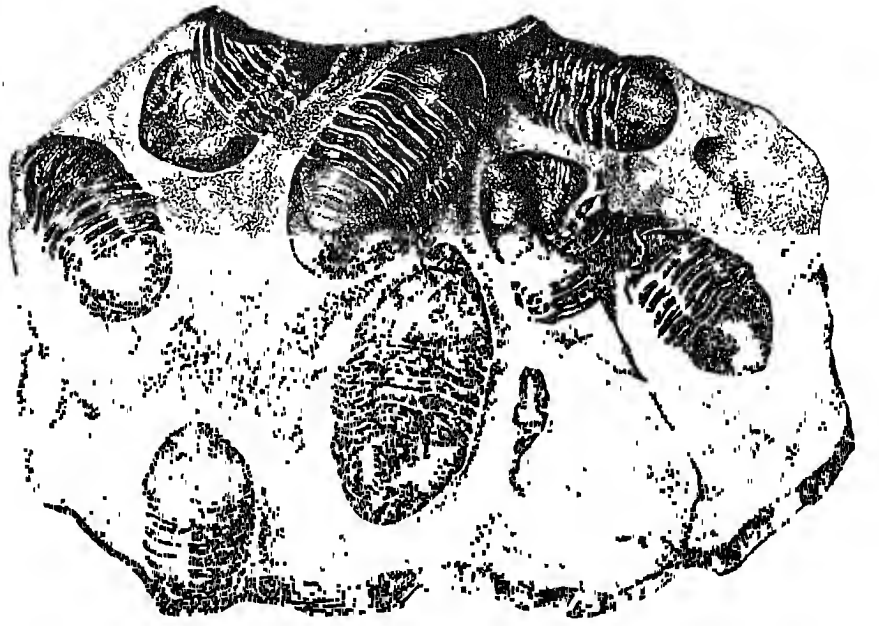


Fig. 14
A piece of rock bearing animal fossils

Sand, gravel and conglomerate are carried by rivers today, as in the past. Such rocks tell us of the fast moving streams, and even of floods.

Now let us consider thick deposits of sand. You find them today, for instance, in deserts like Rajasthan where

the climate is dry and arid. A sandstone rock has a similar story to tell. See Fig. 15 below

A dust storm, as you know, blows the dust from one place to another. When dust settles, it does not make layers like the rocks made in water. Any unlayered dust called loess should immediately recall to your mind the dust storms of the past.

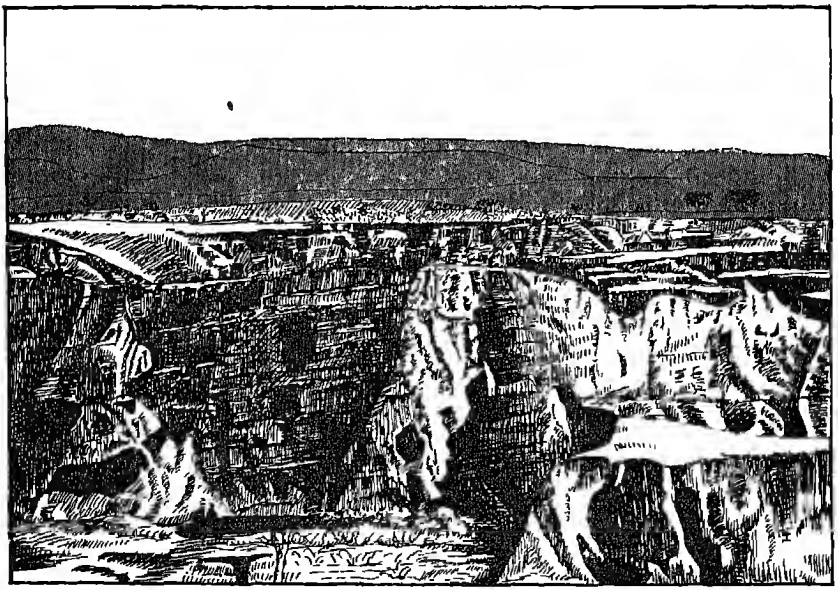


Fig. 15

A thick deposit of wind-blown silt forming high vertical walls and ravines upto 90 m thick It is spread over a large area of northwest Punjab covering depressions, slopes and high ground It indicates a dry period of climate. Locally it is called 'Khuddara.'

Have you visited any hill station in the Himalayas, like, for instance, Darjeeling? Here you will see the snow-clad Mount Everest or perhaps some of you may have seen a snowfall. Ice forms when snow accumulates. Glaciers are slow-moving rivers of ice. They move down the hill slopes and valleys.

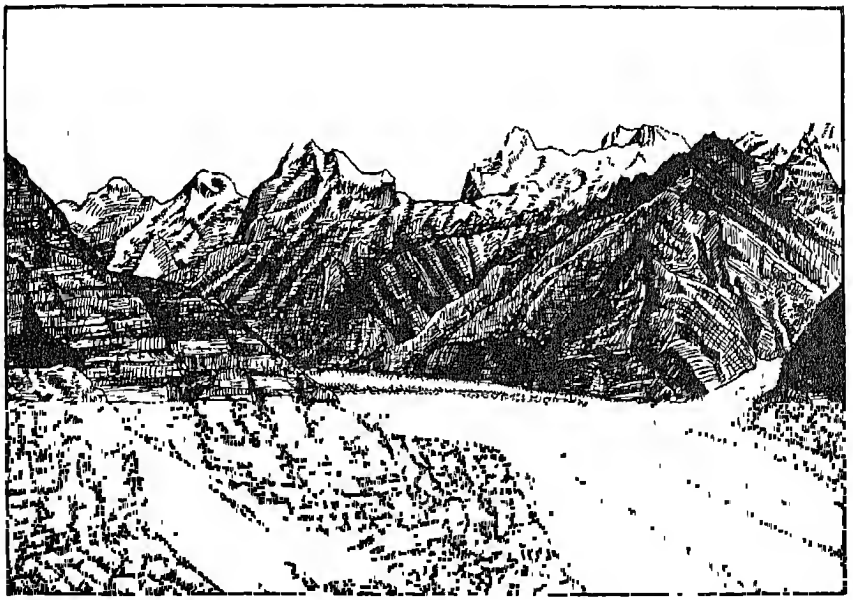


Fig. 16
A Glacier

While moving they rub off the tops of the hills and carry the big boulders along with them. The ice with the boulders acts like a sandpaper The surface of the ground is scratched when the glaciers move over it You can see a scratched pavement in Figs. 17-18.

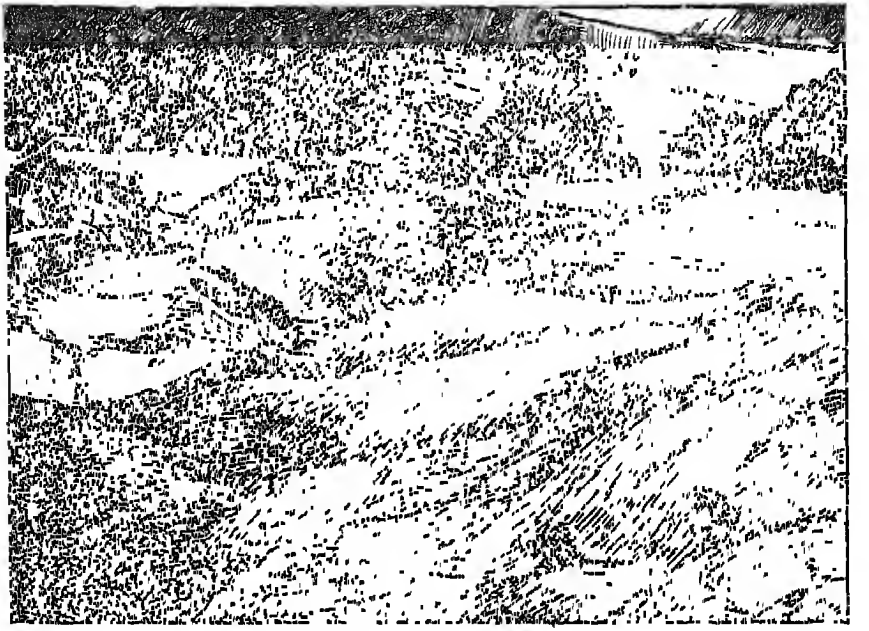


Fig 17
Glaciated pavement

Fig 18
A scratched and faceted pebble

When the climate warms up, the glaciers melt. Ice turns into water which flows out in rushing streams cutting through softer rocks on the way, making raised steps or terraces On reaching the sea, the water raises its level. The sea floods the coastal areas several kilo-

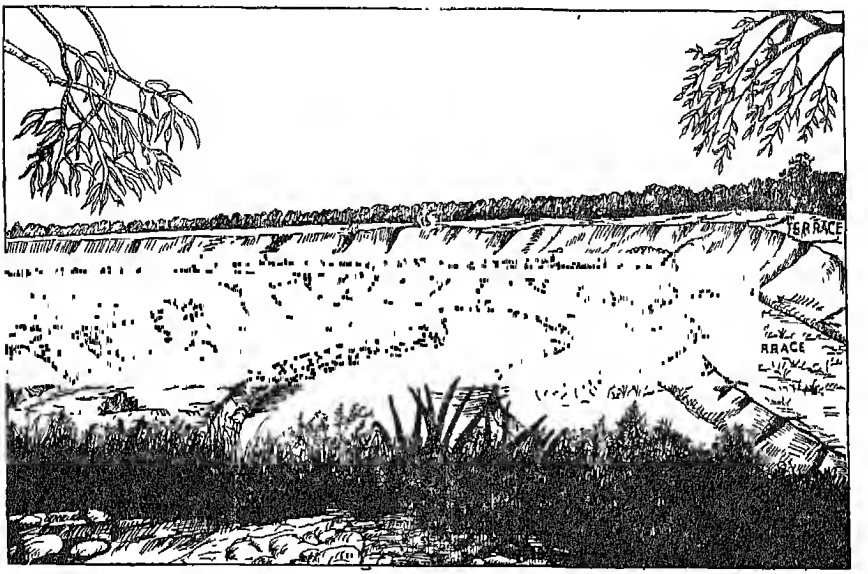


Fig 19
View of land showing terraces cut by the river

metres inland That is what happens to the water when a glacier melts. It also leaves behind large and small boulders to tell the tale. Boulders carried by glaciers are always angular rather than smooth.

Thus, the scratched surfaces, river terraces, sea

sands, several miles inland, and angular boulders, all tell us of the presence of ice in the past. It is for you, now, to imagine how cold it must have been when ice existed in the valleys.

Layers of rocks in lakes or swamps are usually laid

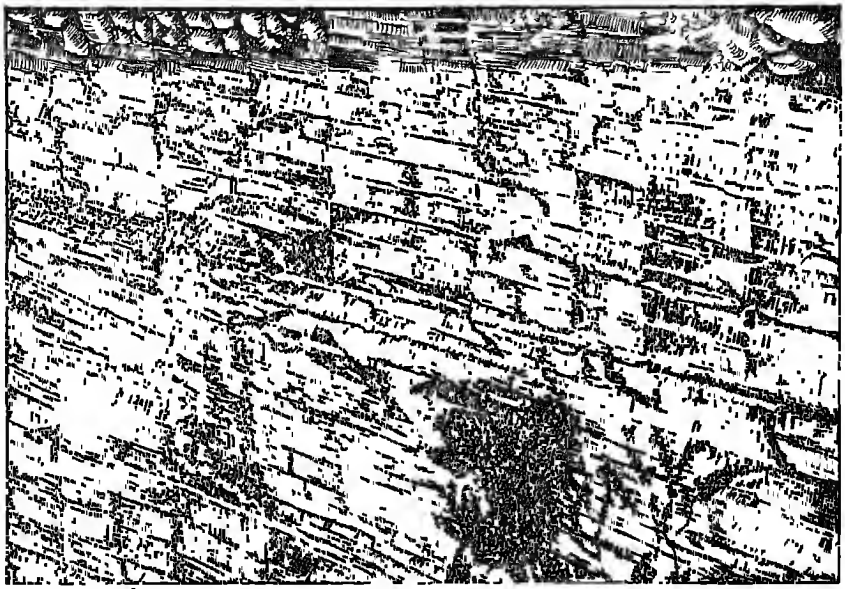


Fig 20
Horizontally laid layers

parallel to one another. They may all be of mud or there may be clay layers alternating with layers of sand, gravel or limestone or coal. The layers may also be bent and folded as shown in Figures 20 and 21.

In some rocks ,the layers may be vertical. These

Fig. 21
Folded and bent layers

layers were laid horizontally at first. The layers became bent and folded because of certain earth movements. When these movements are very strong one part of the layers may be thrown up and another may sink. This is

Fig 22 Weathering of limestone

Fig 23 Erosion

Fig 24 Weathering of granite

Fig 25 Rain pillars showing denudation by rain

how mountains are made or depressions caused.

Wind and water are continuously breaking down the rocks into sand and gravel. These are, in turn, being carried to seas or lakes to make new rocks. The weathering or breakdown of rocks destroys some parts of rocks, and at the same time a part of the history they would have told us. Figures 22-25 show how the weathering of rocks takes place.

Rocks made from lava tell us of the past volcanoes and the floods of lava. About 20-25 million years ago there were numerous volcanoes in Central India. There are none there today.

Igneous rocks tell us of the past conditions of high temperature and pressure. When sedimentary rocks change into igneous rocks, all records of past events contained in them are lost to us for ever. They are completely destroyed.

This is Nature's language and as you can see it is not very different from your own language. To learn to read it, you should try to observe how rocks are being made and unmade in various part of the country.

4. Dating the Events

SOME OF THE events in the earth's history, read from the rocks can, however, be dated from the position of the layers in the rocks. The older (the lower) the layer the more ancient the event is. From the changes in the nature of animal fossils observed in the various strata of rocks, a geological time-table has been constructed. It can be consulted for dating a rock if animal fossils are found in it. This helps greatly to date a sequence of past events, from the most ancient to the modern.

More accurately, the events from the rocks can be dated, through the estimation of certain radio-active elements such as Radium, Uranium and Thorium which are found in rocks in very small quantities. A radio-active substance always breaks down in fixed time into other substances releasing energy in the form of heat. A million grammes of Uranium produce 1/7500th of a gramme of Lead every year. From the amount of Uranium and Uranium-lead present in a piece of rock, it is possible to find the age of the rock in years.

Radio-active Oxygen and Carbon have also been discovered. These help in dating rocks made from plant or animal remains which are not very ancient and to which the above methods cannot be applied for certain

reasons. There are other methods too for dating the rocks.

With the help of these methods it has been possible to date the oldest rocks to about 4,000 million years and the recent rocks to about a few hundred years.

The oldest groups of rocks are called the Precambrian or the Archaean. These range in age from 4,000 to 1,500 million years. Being the oldest they form the foundation of all the sedimentary rocks. They are followed by the formation of Palaeozoic rocks, so-called, because it was during this era or period of time, that early forms of life were discovered This was the age of fish. There were coal formations, and their estimated age is from 6,00 million to 180 million years. Next in formation were the Mesozoic rocks. It was the age of dinosaurs and birds. The Tertiary rocks began to form about 60 million years ago; at this time, hoofed animals and elephants roamed over the Earth. The last and shortest of the geological periods was the Quaternary or the Ice-age. It began about one million years ago. It is only ten thousand years ago that Man emerged as a cultivator and also began to domesticate animals.

5. The Origin of the Earth

THE EARLIEST chapters of Nature's Story Book are so worn out that its pages have become brittle, torn and fragmentary. They are so much spoiled that you can hardly make anything out of them. This is the reason that the origin of the earth is still a mystery. However, it is largely believed that the earth originated from the sun. To begin with, it was burning white hot and was made up of gases. It cooled down rapidly to a liquid state and finally became solid. When first born, the earth was much smaller in size than it is today.

The climate was very hot and tropical when the earth's crust began to form from the gases and the molten matter. As the temperatures fell, steam condensed into water and filled depressions making the seas. The hardened crust formed the land. When first formed the seas were of fresh water which gradually became salt.

6. The Birth and Early Beginnings of India

TO START WITH when the earth came into existence, India and the other continents were without their present shape or form. In the early stages of development, there were neither mountains nor oceans. The plains and plateaus familiar to us did not exist at that time. Then India had quite a different shape from what you see in Figure 26.

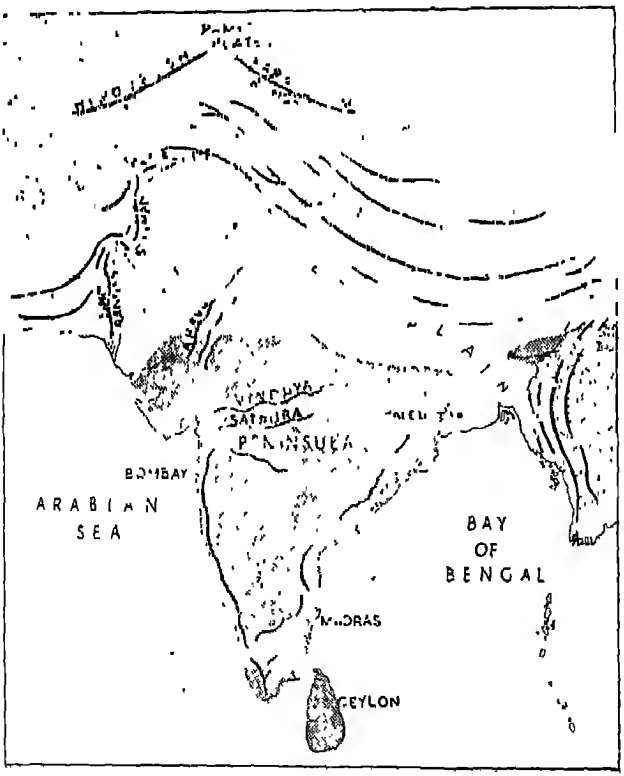


Fig. 26
Map of India showing the physiographical divisions and important hills

A large part of the Indian Peninsula and Central India together with Ceylon and modern Burma had, however, been formed.

As time passed, the newly formed India, was affected by some violent and destructive forces such as earthquakes and the erosion of rocks. Their shape and structure were changed. Certain earth movements or earthquakes gave birth to the Aravalli mountains in the Indian Peninsula. When these forces died out, the land began to sink forming depressions which were filled gradually by thick sediments. Volcanoes existed in certain parts of young India. There was also a sea in Central India. The floor of this sea rose to form the Vindhyachal mountains. Some volcanoes existed in Rajasthan, too. But, there are none there today, as you must be knowing.

During this time there was little life on the earth.

7. The Dark Age

THE CLOSE OF this early period was followed by a Dark Age which lasted for about 300 million years. We may call it the Dark Age, since the rocks of this period are missing in most of India, but those present in the north suggest that the entire north India was under a sea. There were no Himalaya then. In its

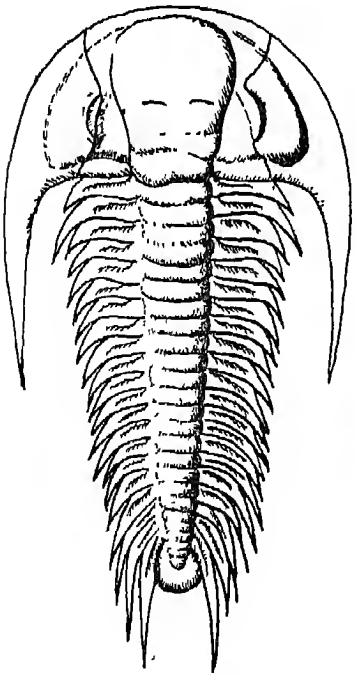


Fig 27A
A Trilobite

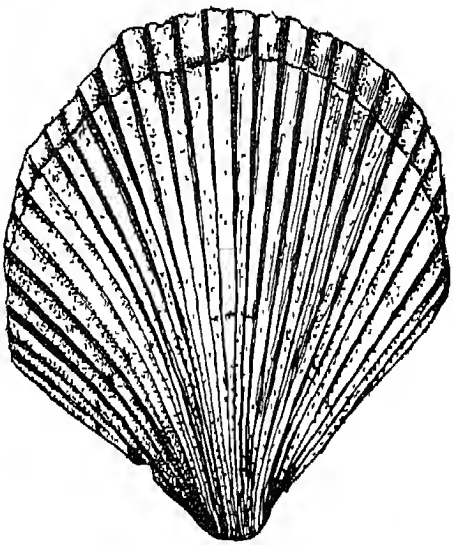


Fig. 27B
A Brachyopod

place there was a sea. This sea was part of the ancient Mediterranean ocean. It encircled almost the whole earth dividing the entire land mass into the northern and the southern hemispheres. This sea has been named the Tethys Sea During this Dark Age some plants looking like ferns grew in the north-west. Scores of animals lived in the Tethys Sea. The sea animals were of a very primitive type. There were trilobites, brachyopods, sponges and corals, as you can see in Figures 27A and 27B.

Several of the animals that lived then are not found today.

8. The Gondwana Land

THE YOUNG INDIA had already been separated from the mother earth by the Tethys Sea. Now it lay far south in the region of the Indian Ocean. Alongside it were East Africa and Madagascar with Australia forming the eastern or southern part of it. To the extreme west, India extended beyond South America which was then joined to South Africa. The southern part of this land mass was Antarctica This land mass, with the Tethys Sea, extending towards the north has been named as Gondwana land. The name 'Gondwana' is derived from the Kingdom of Gonds—a primitive tribe in Madhya Pradesh Towards the North of Gondwana land beyond the Tethys Sea there lay another mass of land, the Angara Land as shown in Figure 28.

For about 70 million years Gondwana land continued as described above About 110-120 million years ago the volcanic eruptions, earth movements and marine floods began to break up this land mass. Australia moved away first. The Bay of Bengal assumed its present shape. South America broke away from this land mass more or less at this time India too was sliced off but it did not move to its present position in the North until about 30 million years later.

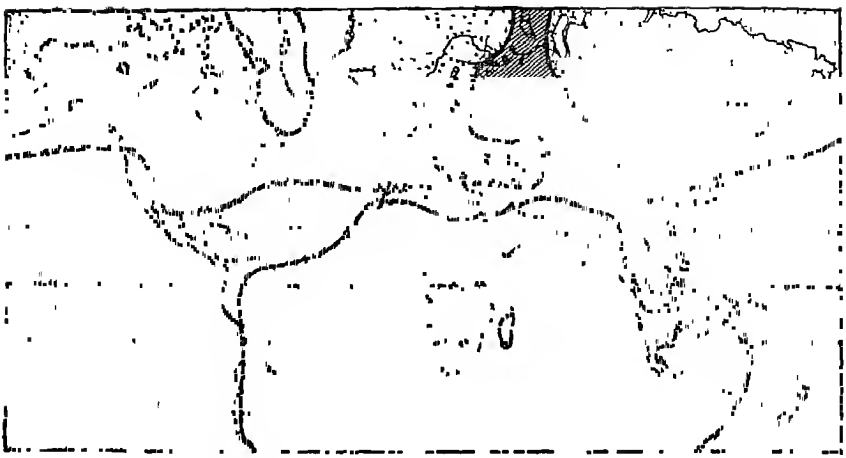


Fig. 28
The Gondwana land

The eastern coast of India was carved out about 150 million years ago.

Some experts believe that instead of being a continuous land mass, Gondwana land was more a sort of an archipelago with several land bridges connecting India, Africa, America and Australia. Figure 29 shows two arms of the sea extending inland. These arms of the sea have remained here for millions of years. The western arm covered the present Coromandal coast and the Narmada valley and the eastern arm covered Assam and a part of the Indo-Gangetic plain. India then was a big volcanic plateau. Hot burning lavas flooded hundreds of thousands of kilometres from coast to coast.

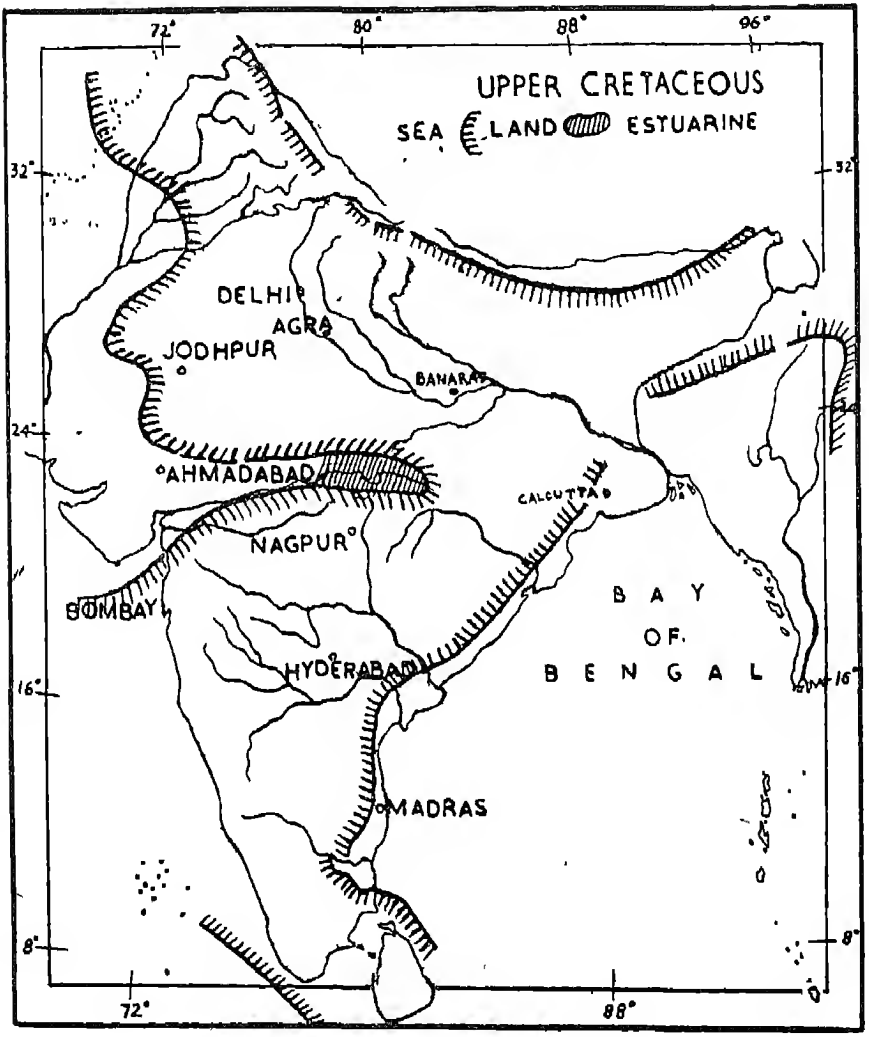


Fig. 29
India during the age of the Dinosaurs

During the early history of Gondwana land, there were glaciers on the Aravallis and the Vindhyas. From there, the ice sheets spread to the west Punjab, Pakistan and Kashmir in the west and to the eastern India in the east. The Tethys Sea extended into western Rajasthan, Sind and part of western Punjab. The climate was ice-cold. When it began to warm up, dense forests of fern-like seed-plants called Gangamopteris and Glossopteris together with several other plants were formed. Swamps inhabited by ganoid fish and reptiles were very common—

Fig. 30
Landscape of Gondwana land

Figure 31 shows a landscape of Gondwana land. It was during this time that thick deposits of coal were formed.

The warm and moist climate became dry about 180 million years ago. Now there were new types of forests. There were huge reptiles and fish which could live on land as well as in water. This was the age of Dinosaurs.

About 30 million years later the climate became warm and moist again and the ancestors of the modern forest trees came into existence at this time. The forests consisted of plants such as conifers and cycads and ferns as you can see in Figures 31 and 32.

Fig. 31
A Jurassic Landscape

The sea animals were now more advanced than those which lived previously. Amongst them the cephalopods

Fig. 32
A Jurassic Landscape of the Rajmahal Hills, Bihar

and the lamellibranchs were very common. Birds appeared for the first time.

Towards the close of this Golden Period the plants which produced flowers came into existence.

9. The Shaping of Modern India

ABOUT SIXTY million years ago, India took its present shape and form. It broke away from the landmass of Gondwanaland. Nature celebrated it with the rip and roar of volcanic eruptions. It poured out large quantities of red-hot lava over almost half a million square kilometres of land Violent earthquakes broke Gondwana land into fragments which moved in different directions. The bottom of the Tethys Sea began an upward movement. It went over and above the sea-level forming the Himalayas. A long and narrow trough was

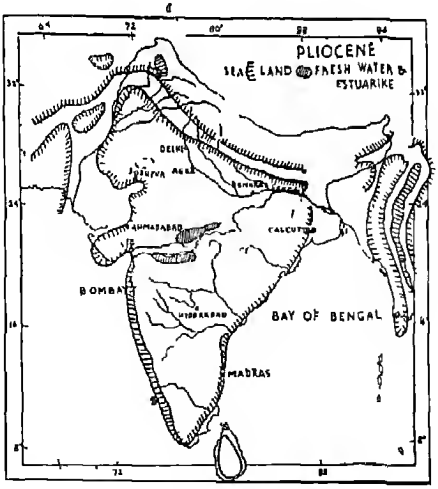


Fig. 33
India just before the beginning of the Ice-Age

formed between the Himalayas and the Peninsula. This trough was later filled up with sediments and formed the modern Indo-Gangetic Plain. In the north-western part of India the last remains of the Tethys Sea disappeared gradually.

The rivers, as you may imagine, must have flowed into the Tethys Sea in the north and north-west. Now they changed their direction. The Indo-Gangetic Plain was drained by a mighty river called the Indo-Brahma. Figure 34 shows that the Indo-Brahma discharged its water into the Arabian Sea. With the rise of north-western India, the Indo-Brahma was now split up into the present Sind River and the Brahmaputra. Since then the Brahmaputra has been discharging water into the Bay of Bengal.

The Tethys Sea had disappeared and an ocean surrounded the peninsula. The direction of the winds had also changed. There were snow deposits on the peaks of the Himalayas. Rain forests existed in several parts of India, even in Rajasthan which is a desert now. A large number of animals like the rhinoceros, giraffes, horses, snakes, apes and elephants lived in these forests. Crocodiles swarmed in the water.

Nature, in the meanwhile, was busy building up a chain of mountains in the north, and minor hill ranges elsewhere. An ocean known to us as the Indian Ocean was made. We had, also, at this time the beginnings of

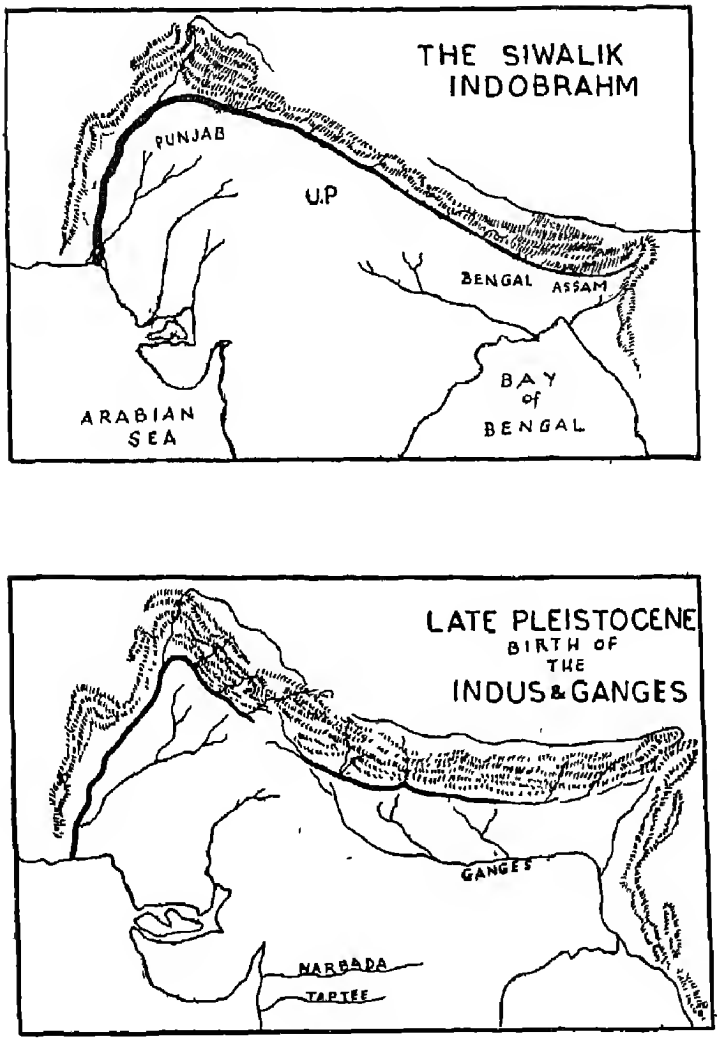


Fig. 34
The birth of the North Indian Rivers

our modern rivers.

As mentioned earlier, the Indo-Gangetic plain was formed in this period. The finishing touches to the geography of modern India were given by nature, in this period of the last one million years.

The Quaternary or the Great Ice-Age was the most recent geological period of time. This was marked by great earthquakes, and the Himalayas attained their present height then. The valleys at high altitudes were covered with glaciers. The climate became icy-cold as the glaciers moved down to the foothills. A severe cold wave gripped North India for thousands of years The Indian peninsula experienced heavy rains. The glaciers began to melt and recede, and hence the climate became warmer. The water released from the glaciers flooded the streams. The rushing streams moving with great speed cut through the valleys and made huge gorges A great load of detritus was deposited on the eroded surfaces of the valleys. The water level of the ocean rose and flooded the coastal areas. Figure 35 shows how Bengal was flooded by sea when the glaciers had melted.

From the rocks we know that there had been four such major severe cold waves in North India. Each was followed by a warmer phase. The alternation of the cold and warm periods made several raised or terraced steps along the banks of the rivers.

The last major cold wave ended about 10,000 years

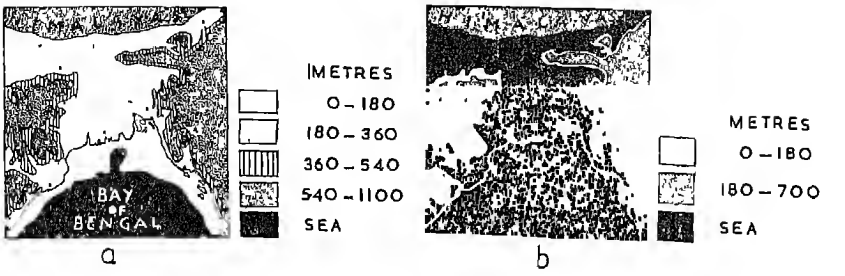


Fig. 35

Bengal during the Ice-Age

Note the flooding of Bengal by Sea when ice on hills melted The indices which show the heights above sea level in Fig 39 are as follows :

a Shows the fall in sea level in the Bengal basin during the period of glaciation when the water of ocean was locked up in glaciers.

b Shows flooding of the Bengal Basin during inter-glacial period when glaciers melted and restored water to the ocean thus raising the sea level Simultaneously there had occurred earth movements too which also affected the changes in the sea level.

ago. The repeated periods of severe cold waves destroyed a vast population of animals and plants that had lived here before. This drove animals from the neighbouring countries into India. Of the several kinds of elephants that had dwelt in our forests, only one kind, the modern elephant has survived. The ape-like animals changed into man during this Great Ice-age. It is, therefore, also called the Age of Man.

The early man was not very different from the other animals in his mode of living. He used to hunt animals and gather food rather than cultivate it.

Then finally modern India emerged as we see it today. During hundreds of million years, slowly and steadi-

ly and inch by inch, Nature created plains, hills, oceans and plants and animals of various kinds from the mortar and cement it had in store. The history of India's making is the history of its origin, the rise and fall of mountains, the distribution and readjustment of the sea and land and a continuous panorama of the evolution of plant and animal life. Several animals and plants either fell never to rise again or underwent new forms, until in Man a new force appeared which began gradually to subdue Nature around him.

10. Rocks and the History of Man

MUCH LESS DIRECT evidence has come forth from the rocks about the history of Early Man. The mute sediments and early man's preserved stone tools as you see them in Figures 36-38 tell us all about him. He used to live close to rivers or lakes along the edge

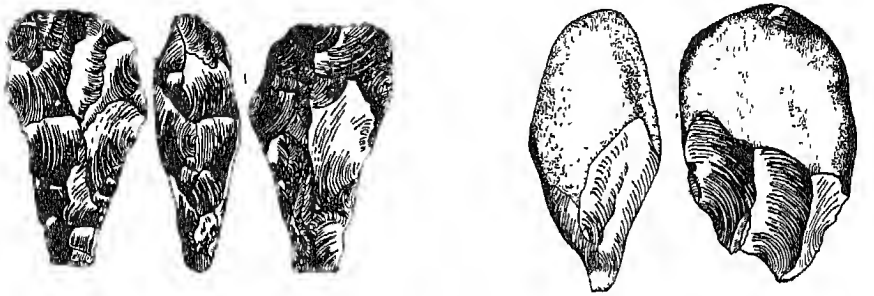


Fig 36
Stone hand axe
(Showing different views)

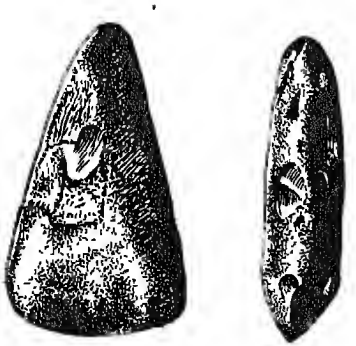


Fig. 37
Polished stone axe
(Showing different views)

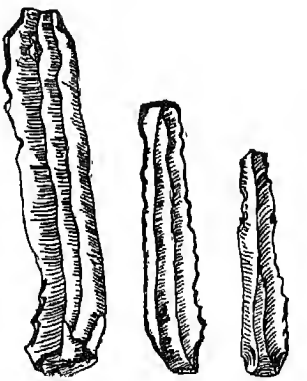


Fig. 38
Stone blade
(Showing different views)

of the forest, on higher ground beyond the reach of the floods He also inhabited the caves He manufactured his tools from the stones. He would often drag his prey to his residence for an enjoyable feast.

The Early Man was very adventurous Without much equipment and any means of transport he roved over hills and plains, over the glaciers and gravel in rain or storm, carrying his little kit, the stone tools which were all his belongings. This pioneer explorer wandered for years and years, even then his journeys never came to an end

The Early Stone Age Man manufactured crude stone axes and stone hammers Later, he used a wooden mallet for finer pieces of work. He had some contact with the Early Stone Age Man of South Africa. During this time the Early Stone Age Man in the North used to a large extent flake tools, choppers and scrapers made from pebbles. It is believed that the hand axes used by the Early Stone Age men in the North were probably gifted to them by those in the South. These cultures existed during the second and the third severe cold waves, about 450,000 and 200,000 years ago respectively.

About 10,000 years ago at the end of the last severe cold wave, the early Indians had developed small-sized stone tools. This was the Mesolithic Age. These small stone tools called the microliths were mounted together on a handle of wood to form a cutting edge. This cultural

change came because the gigantic animals like the mammoth rhinoceros and bison had disappeared. There were now deer, pig and other small animals. The microliths were also used by these men for cutting their way through the forest. They had established contacts with the Mediterranean folk and with the negroid races that lived there.

After the Mesolithic Age, the New Stone Age began. The New Stone Age man polished his stone tools and made utensils from clay. He was the most highly advanced of the Stone Age men. Though fire had been known earlier he made a different use of both fire and forest. He felled the forests and practised agriculture. He sowed the first seeds of our civilization. He cultivated rice, as you can see in Figure 43, and other food grains.

Fig 39
Rice cultivated by Stone Age people

Figure 40 shows that both the Early and the Late Stone Age folk spent their leisure hours in making drawings, usually showing hunting on rocks. They also coloured their drawings of animals.

Fig. 40
Painting on rocks

About 4,000 to 5,000 years ago a great civilization developed in Sind, Punjab, Western Uttar Pradesh, Rajasthan, Kutch and Gujarat. People used rice, wheat and barley. They made utensils from clay as well as from copper. Their hearths and homes were built of bricks. The periodic floods in the rivers destroyed this civilization. This culture was of a highly advanced type. Women wore ornaments and children used to play with several kinds of clay toys. They used to bury their dead and keep pots and stone tools along with the dead body.

The climate was dry during the Indus-Valley civilization or the Harappan civilization*. The forests were felled to provide fuel for cooking, for baking bricks and for smelting copper and to provide land for cultivation. The continuous felling of forests changed the once-forested tracts into desert. This is how Rajasthan became a desert.

This is in short what rocks tell us about the history of Man in India. In the beginning Man was completely dependent upon Nature for several thousand years. He lived like any wild animal; later he laid the foundation of modern society and agriculture. From stones that meant so much to him, he now shifted to metals. First to copper and then to iron, but, stones continued to play an important part in his life.

Some time during the late Metallic Age, Man discovered the art of writing and began to write his own history. But Nature has continued her task. The newly-formed soils and rocks in swamps and lakes have been and are continuously recording the events.

*This great civilization ended about 1750 B.C Thereafter several less developed copper using cultures emerged in various parts of India. Iron began to be used in India about 3,000 years ago by people who are believed to be the Aryans.

11. The Procession of Life

By now you have seen that Nature's Wonder Book describes several interesting things that happened in the past. There was sea, where there is none today. The sea floor rose to form the Himalayas—the highest mountains in India. Forests once grew where you have a desert today. There were volcanoes and floods of lava. No such matter exists in India today Some parts of land rose into hills, others sank below the sea. There were severe cold waves followed by warm periods. All such events which we have read from rocks have helped plants and animals change into their new forms. Several varieties became extinct and other new forms came up. The procession of life marched forward in this way until the plants and animals we see today came into existence. Some of those that died left behind their dead remains in the form of fossils. A fossil bone, a fossil leaf or a fossil fruit that has been found in the rocks tells about the march of life in the millions of years that have gone by.

Looking back to the earliest times, the plants and animals were so simple in structure that it is hard to tell which of them were plants and which were animals. They were so alike. This was the Age of Simple Plants and Animals.

As time passed the plants and animals which now joined the procession were more complex than those of the earlier times. The animals did not have a backbone. There were sponges, corals and starfishes amongst them. Several of them used to live in colonies. Some of them had delicate bodies protected by hard shells as you find in snails and cuttlefishes. Gradually the animals without backbone became still more complex. Now lobsters, crabs, cockroaches, earthworms and insects also joined the procession. The cockroaches then were four times longer than we have them today. There were scorpions and spiders too. The dragonflies were huge with a thirty inch wing-spread.

The early land plants in this procession were delicate and small in size. They had no leaves, no roots, no flowers and no fruits.

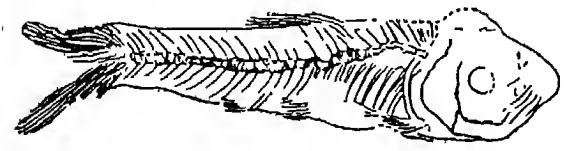


Fig 41
A fossil fish

Several hundred million years later animals with backbones joined the procession. The first among them were the fish. It was the Age of the Fish. There were sharks, skates and rays.

Salmons, herrings and perches joined much later. There were no whales then. Perhaps you know a whale

is not a fish. Some of the fish about 50 million years ago were as long as eighty feet.

Together with the fish there were several other kinds of animals, as well. They could live both in water and on land and were known as amphibians. Some of them

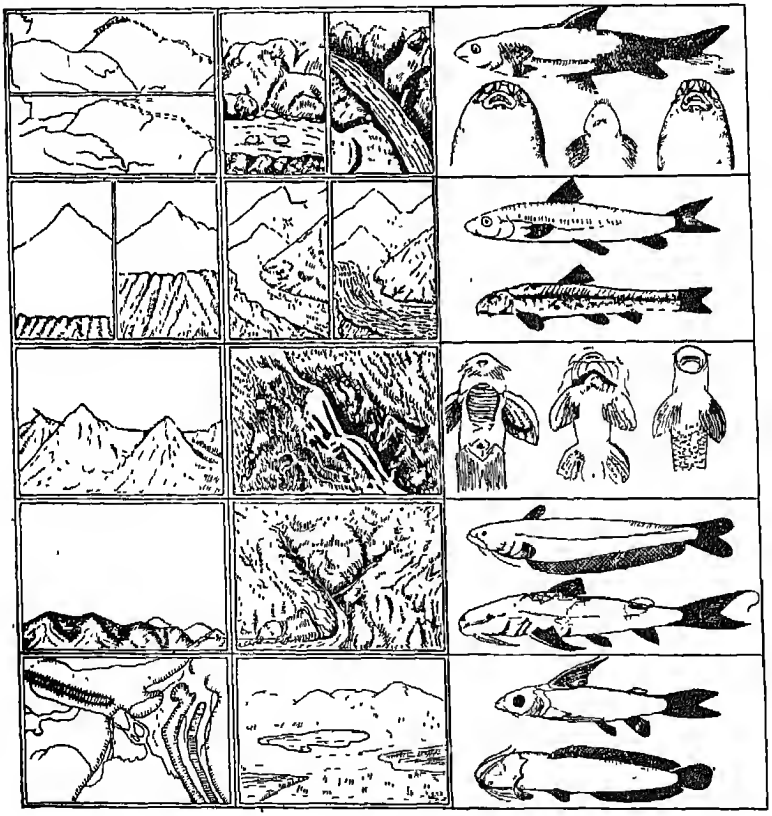


Fig. 42
Evolution of Indian fish

were very huge and had large skulls. Their bodies were upto fifteen feet long. Their heads were protected with thick horny plates. Then came frogs, toads and salamanders.

About 180 million years ago, the Age of Dinosaurs began. The animals looked like lizards and were mostly sluggish. But they were large and terrible animals. Some of them weighed about 50 tonnes. They were 26 metres long and 6 metres or more high. Their thick skins bore horny scales and bony plates. Some of them could fly, too. Turtles, snakes, crocodiles and modern lizards came later.

The birds came on the scene when the Dinosaurs were still roving the earth. They were, at first, of the size of pigeons, and had long tails. Sea gulls were, also, there. Sixty million years later a whole species of birds joined the procession.

The hoofed animals came into existence nearly 50 million years ago. Their size was diminutive in the early years. In this cavalcade there were also, animals which looked like small elephants, but had no trunks. They had three pairs of horns on their heads. They ate the leaves of trees and birds. Amongst other animals there were small-sized camels and rhinoceros. The latter were akin to sheep in appearance.

Several million years later the elephants, camels and horses developed into large animals. There were cats,

dogs and wild cattle, too Monkeys, apes and chimpanzees appeared a little later.

As soon as the first severe cold wave came, it became unbearably cold. Most animals in the procession could not stand it. They searched for warmer places which were far-off. Several of them died on the way. Of the several kinds of elephants only one—our modern elephant —survived. The huge procession was now reduced to a small one. It only consisted of such animals as could live in the cold of the Ice Age. Now Man came on the scene. In terms of biological time, he came to exist a million years ago.

The leafless, rootless and flowerless, green members of this procession, about which you have read above were soon followed by new kinds of plants. They had roots, leaves and fruits, but, still no flowers. This was the Age of Flowerless Plants. There were ferns, some of which were tree ferns. There were tall and huge, club mosses and tree-like horsetails about 12 metres tall Perhaps you know how small and delicate are our club mosses and horsetails today. There were also ferns which bore seeds on their leaves. These were the earliest seed plants. Besides there were other kinds of trees too. All these formed thick swamp forests The coal that we burn was made from these forests.

With the passing of time, there were now different kinds of trees in the forests. There were conifers, cycads

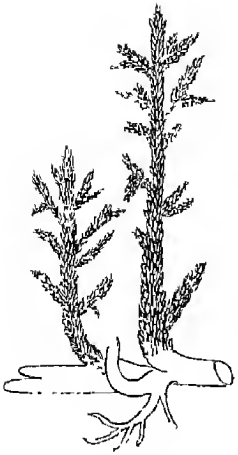


Fig 43
A fossil early land plant

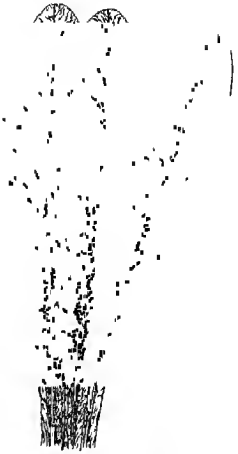


Fig 44
A seed fern

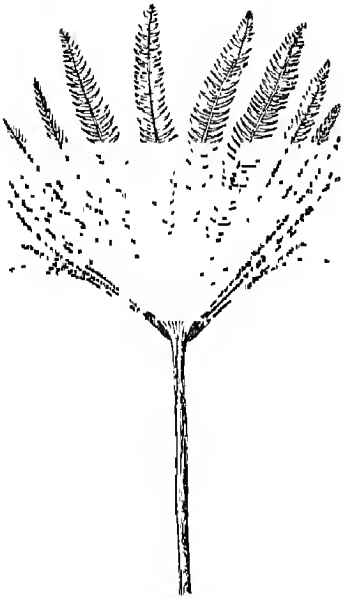


Fig 45
A fossil fern

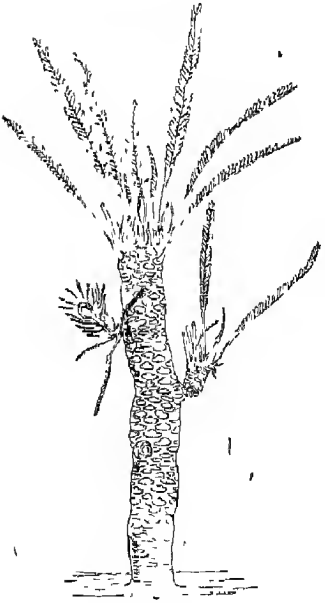


Fig 46
A cycad-like fossil tree

and maidenhair trees, and a new variety of ferns. The seed ferns had all died out. Several other kinds of plants which existed before had also become extinct. The club mosses and horsetails were now as small and delicate as we have them today. This was still the Age of Flowerless Plants. How dull the procession of life must have looked without the flowering plants?

About 90 million years ago the plants which produced flowers appeared. They had small flowers, which were colourless and scentless. But, there were flowers like those we have now. Suddenly they spread over the mother earth and became very common. The Age of the Flowering Plants had now begun. Sometime later, the procession became colourful as the plants with large, beautiful and coloured flowers came into being.

How interesting indeed is the Wonder Book of Nature! The stories read from the rocks tell us how and when certain mountains, valleys and oceans were made. The rocks unfold the history of both the plants and animals, and our own history too. Without rocks we would never have known how the poor mother earth has suffered in millions of years. Many times the hot lava burnt its body and often earthquakes shook it violently. There were moments when it was frozen and buried under thick ice-sheets. The moving glaciers crushed it under their feet. Frequently it was stripped off its wear—the green mantle—which it has changed many times. And the earth

movements broke its parts. Though bruised and baked and scarred and frozen, mother earth struggled along.

During these periods of trial, there were quiet moments, too, when the tired and worn out mother earth rested and gasped for breath. Her sufferings were witnessed by the leaves and fruits which fell into the water. They became the recorders of the events of the past. And, the animals left behind their dead bodies, in order to tell the tale. Like a small diary, the lakes and oceans have kept the records in their sediments.

Perhaps, Nature did not like its cruel acts to be recorded that way. There were attempts to destroy the lakes and seas and the layers of rocks formed in them. Some rocks were destroyed. Some were bent and folded and twisted but continued to unfold the past,

GLOSSARY OF TECHNICAL TERMS

1 **Archipelago** A sea or broad sheet of water interspersed with many islands or a group of islands such as the Malay Archipelago.

2 **Basalt.** A fine-grained igneous rock formed from lava flow. It is a basic group of rocks.

3. **Boulder.** A large and coarse pebble

4 **Brachiopods** Sea animals with bilaterally symmetrical shells made up of lime. The shells, either convex or flat, are held together with a hinge structure or muscles.

5. **Cephalopods.** Sea animals provided with coiled and many chambered shells

5(a) **Club mosses.** Delicate and leafy plants few inches high called *Lycopodium.*

6 **Conglomerate.** A hard or loose rock made up of rounded fragments of other rocks embedded in finer composition

7. **Conifers.** Plants having the seed-bearing organs aggregated into cones Leaves are small.

8. **Corals.** Flower-like sea animals living in shallow seas Many of them live together in colonies several feet across

9. **Cycads.** Palm-like plants which have seed-bearing organs aggregated into cones.

10 **Detritus.** Fragmented material such as sand and mud derived from the breaking up of rocks.

11. **Dinosaurs.** Huge terrible lizards of the past.

12. **Ferns.** Seedless plants with usually underground stems bearing several branching leaflets with spore clusters on the underside of the leaves Some are tree-like

13 **Fissures.** Cracks.

14 **Fossil.** The traces of past animals and plants formed naturally embedded in rocks, such as bones, shells, twigs, leaves, seeds and fruits, either as moulds, casts or impressions.

15. **Ganoid fishes.** Fishes having scales composed of an inner layer

of bone and an outer layer of shining enamel

16 **Gorge.** A narrow, deep and steep passage through a mountain made by a river

17. **Granite.** A coarsely crystalline acid plutonic rock.

18 **Gravel.** A loose sediment consisting of round or angular pebbles from 2 to 10 mm in size.

19. **Horse tails.** Leafless plants with unbranched, jointed and ribbed stems called *Equisetum.*

20 **Indo-Gangetic Plain.** Vast plain in the North of India drained by the Rivers Indus and Ganges.

21. **Lamellibranchs.** A class of mollusks that have bivalve shells such as oysters.

22. **Loess.** A deposit of very fine silt distributed by wind and accumulated in thick deposits

23 **Maiden-hair tree.** The Gingko tree. A large and ornamental tree from China and Japan.

24 **Metallic age** A period in human history when metal was introduced for the first time.

25 **Microliths.** Small stone tools

26. **Quartzite.** A granulous metamorphic rock made up of re-crystallized sandstone

27 **Reptiles.** A great group of animals to which lizards, crocodiles and snakes belong.

28 **River terraces.** Flat, step-like strips on the flanks of a river valley at various levels above the present channel.

29 **Sedimentary rocks.** Loose and hard rocks formed of sand, mud and/or fragments of plants deposited at a place.

30. **Sponges.** Mostly sea animals. These are hollow, globular or cylindrical animals with a large opening at the top and with limy skeletons

31 **Stone tools—implements and instruments.** Hammers, axes, scrapers, knives etc. made from stone

32. **Strata of Rocks.** Layers of rocks ('strata' is plural of 'stratum' meaning a layer).

33. **Swamps.** Wet, spongy land or soft low ground saturated with water.

34 **Tethys Sea.** The name given to a mediterranean sea, separating the Gondwana Land from the northern continent in the Geological Ages In India it extended where the Himalayas exist today

35. **Trilobites.** Extinct sea animal made up of a three-lobed shell—a broad head, segmented body with jointed legs and often a tail also.